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<p>(21) International Application Number: <b>PCT/FI95/00372</b> (22) International Filing Date: <b>27 June 1995 (27.06.95)</b> (30) Priority Data: <b>943150 30 June 1994 (30.06.94) FI</b> (71) Applicant (for all designated States except US): <b>NOKIA TELECOMMUNICATIONS OY [FI/FI]; Mäkkylän puistotie 1, FIN-02600 Espoo (FI).</b> (72) Inventor; and (75) Inventor/Applicant (for US only): <b>PIIRAINEN, Risto [FI/FI]; Soratie 21 A 2, FIN-90650 Oulu (FI).</b> (74) Agent: <b>OY KOLSTER AB; Iso Roobertinkatu 23, P.O. Box 148, FIN-00121 Helsinki (FI).</b></p>		<p>(81) Designated States: <b>AU, CN, DE, GB, JP, NO, US, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).</b>  <b>Published</b> <i>With international search report.</i> <i>In English translation (filed in Finnish).</i></p>
<p>(54) Title: <b>SUMMING NETWORK</b> (57) Abstract <p>The present invention relates to a summing network for combining and feeding radio frequency signals supplied by radio transmitters (TX) to common antenna means, which summing network comprises conductors (6), connectors (5) and a stub (1). In order to make the tuning of the summing network easier, the stub (1) comprises means for changing the electrical length of the summing network as a response to a control signal fed to the stub (1).</p></p> <div data-bbox="922 1167 1377 1764"><p>The diagram shows a summing network. On the left, four identical branches are stacked vertically. Each branch starts with a box labeled 'TX' (radio transmitter), followed by a circle with a dot (representing an antenna or connector), then a wavy line (representing a conductor or transmission line), and finally a small vertical line with a horizontal bar (representing a connector). These four branches are connected to a common vertical line on the right. This common line is labeled 'ANT' at the top. A horizontal line labeled 'CONTROL' is connected to a rectangular block labeled '1' (the stub), which is in turn connected to the common vertical line. The common vertical line is also labeled '6' at the top and '5' near the bottom. The rectangular block '1' is labeled '1' and '4'.</p></div>		

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### Summing network

The present invention relates to a summing network for combining and feeding radio frequency signals supplied by radio transmitters to common antenna means, which summing network comprises conductors, connectors and a stub.

The invention especially relates to a summing network of combiner filters of a base station in a cellular radio network. A combiner filter is a narrow-band filter which resonates exactly on the carrier frequency of a transmitter coupled to it. In the base station of a cellular radio system, for example, the signals obtained from the outputs of the combiners are combined by a summing network of a transmitting antenna, which summing network usually consists of a coaxial cable leading to the base station antenna, to which coaxial cable the combiner filters are usually coupled by T-branches.

In order that as much as possible of the transmitting power of the base station transmitters can be forwarded to the antenna (and not be reflected back to the transmitter), the summing network should be tuned with regard to frequency channels used by the transmitters of the base station. The summing network is optimally tuned (is in resonance), if the electrical length of its cables corresponds to a multifold of half the wavelength of the signal to be transmitted. Strictly speaking, a summing network is thereby tuned on one frequency only, but the mismatch does not at first increase very fast when the frequency changes away from the optimum. In practice, the summing network is usually optimized to approximately the centre of the frequency band of the base station, in which case the transmitting power of transmitters that operate at the edge of the frequency band can also be supplied to the base station antenna without significant losses.

In practice, however, the usable frequency band of a summing network is too narrow for the frequency channels of the base station transmitters to be changed very much without having to deal with the tuning of the summing  
5 network. So, need has arisen for a fast and simple adjustment of the tuning of the summing network.

A prior art solution is known for tuning a summing network, in which solution a stub is coupled to the summing network. Said stub is coupled to the last T-branch of the  
10 summing network in which case it connects to a connector which would otherwise be left open. The stub contains a short-circuit screw which short-circuits the outer conductor and the centre conductor of a coaxial cable. The physical position of the short-circuit screw can be shifted  
15 within a certain adjusting range. The position of the short-circuit screw determines the electrical length of the stub, and thus of the summing network which consists of coaxial cable and connectors, i.e. the frequency to which the summing network is tuned.

The most serious weakness of the aforementioned,  
20 prior art, stub is the difficulty in adjusting it. The stub has to be adjusted manually by shifting the position of the short-circuit screw. The measure in question requires a visit by a service man to the site, which in turn takes a  
25 lot of time and increases costs. The object of the present invention is to solve the aforementioned problem, and to provide a solution for making the tuning of a summing network easier. This object is achieved by a summing network of the invention characterized in that the stub  
30 comprises tuning means for changing the electrical length of the summing network as a response to a control signal fed to the stub.

The invention is based on the idea that the tuning of the summing network for a new frequency range is made  
35 considerably easier and faster as the stub is provided with

tuning means for changing the electrical length of the summing network by means of a control signal fed to said stub. Thus, for example, the tuning of the summing network can be carried out by remote control without service personnel having to visit the location. The summing network of the invention is especially advantageous in a base station of a cellular radio network, which base station is employing automatically tunable combiner filters. A solution of this kind makes the service procedures required in the changing of the frequency channels of the base station considerably easier. Thus, easy and fast tunability is the most significant advantage of the summing network of the invention.

The preferred embodiments of the summing network of the invention are shown in the attached dependent claims 2 - 8. In the following, the invention will be described in greater detail by means of a number of preferred embodiments of the summing network of the invention with reference to the accompanying drawings in which

figure 1 shows a summing network of a base station,

figure 2 shows a first preferred embodiment of the summing network of the invention,

figure 3 shows a second preferred embodiment of the summing network of the invention, and

figure 4 shows a third preferred embodiment of the summing network of the invention.

Figure 1 shows a summing network which can be, for example, that of a cellular radio system such as NMT (Nordisk Mobil Telefon), DCS (Digital Cellular System) or GSM (Groupe Spécial Mobile).

The summing network of figure 1 consists of coaxial cables 6 and T-branches 5. The coaxial cable from the upmost T-branch is coupled to the base station antenna ANT, and a stub 1 is connected to the connection of the

lowest T-branch.

The base station of figure 1 comprises four radio transmitters TX. The radio frequency signals supplied by the transmitters TX are directed through circulators 3 and narrow-band combiner filters 4 to a summing network through T-branches 5. In order that as much as possible of the transmitting power of the base station transmitters is supplied to the antenna without being reflected back from points of mismatch, the electrical length of the cables 6 of the summing network must be one half of the wavelength of the carrier wave of the signal to be transmitted. Thus, the summing network is completely tuned (in resonance) on one frequency only, but the mismatch usually does not at first increase very fast when the frequency changes away from the optimum.

The combiner filters 4 of figure 1 are tunable, i.e. their frequency can be adjusted in a way known per se to correspond to the frequency channels used by transmitters TX. However, the adjustment/change of the frequency channels of the transmitters TX leads to the need for the summing network to be re-tuned to correspond to the new frequency channels. Said tuning is carried out by the stub 1 of the invention, which stub, as a response to a control signal fed to it, changes the electrical length of the summing network.

A control signal can be supplied to the stub 1 of figure 1 so that, for example, a base station controller or a similar control unit feeds a control signal to the stub 1, which control signal indicates the centre position of the frequency channels of the base station. If the base station comprises means for measuring the power reflected back from the points of mismatch, the stub can be supplied with a control signal which is based on the power reflected back from the points of mismatch of those transmitters TX using the outermost frequency channels. Measuring means of

this kind are already known in connection with automatically tunable combiner filters, and thus they are not dealt with in any greater detail here.

Figure 2 shows a first preferred embodiment of the summing network of the invention. Figure 2 shows stub 1 of the summing network, and a T-branch 5 by which the stub 1 is connected to the summing network.

As figure 2 illustrates, the stub 1 includes a coaxial cable 6 whose centre conductor 7 is arranged to fit into a cylindrical grounding element 8. Slide contacts 9 are connected to the grounding element 8, which slide contacts are arranged to touch the centre conductor 7. In order to shift the contact point in question, the stub 1 comprises a transmission mechanism and an electric motor which, as a response to a control signal fed to it, moves the grounding element 8 and slide contacts 9 vertically in relation to the centre conductor 7, so that the contact point between the centre conductor 7 and the slide contacts 9 shifts, and, as a result, the electrical length of the summing network changes.

Figure 3 shows a second preferred embodiment of the invention. Figure 3 to a great extent corresponds to the embodiment of figure 2 with the exception that in figure 3 there is no galvanic coupling between the centre conductor 7 and the grounding element 8. Thus, figure 3 shows a capacitive adjustment in which the electrical length of the summing network depends on how long a portion of the centre conductor 7 at a given moment goes into the cylindrical grounding element 8.

Figure 4 shows a third preferred embodiment of the invention. Similarly to the situation in figure 3, the change in the electrical length of the summing network in figure 4 is based on capacitive adjustment.

As shown by figure 4, the stub 1 is coupled to the T-branch 5 of the summing network by a coaxial cable 6. The

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centre conductor 7 of said coaxial cable is grounded by a capacitance diode 11. By an adjustable power source 12, a reverse direct voltage is obtained across the diode 11, and thus the capacitance of diode 11 is inversely proportional to the voltage level (an increasing voltage reduces capacitance). The choke 13 of figure 4 separates the power source 12 from the RF line.

It should be understood that the description above and the attached drawings are only meant to illustrate the present invention. Different kinds of variations and modifications will be obvious for a person skilled in the art without departing from the scope and spirit of the attached claims.

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## Claims

1. A summing network for combining and feeding radio frequency signals supplied by radio transmitters (TX) to common antenna means (ANT), which summing network comprises conductors (6), connectors (5) and a stub (1), characterized in that the stub (1) comprises adjusting means (8 - 13) for changing the electrical length of the summing network as a response to a control signal fed to the stub (1).
2. A summing network as claimed in claim 1, characterized in that each radio transmitter (TX) is arranged to supply radio frequency signals to tunable filtering means (4) whose output is coupled to the summing network by a connector (5).
3. A summing network as claimed in claim 1 or 2, characterized in that the summing network consists of coaxial cables (6) connected together by T-branches (5), and that the stub (1) is mounted to one of said T-branches.
4. A summing network as claimed in claim 3, characterized in that the adjusting means (8, 9, 10) are arranged to change the electrical length of the summing network by shifting the grounding point of the centre conductor (7) of the coaxial cable.
5. A summing network as claimed in claim 4, characterized in that the adjusting means comprise slide contacts (9) whose one end is arranged to have a contact with the centre conductor (7) of the coaxial cable, and whose other end is grounded, and a transmission mechanism (10) which advantageously comprises an electric motor for shifting the contact point between the slide contacts (9) and the centre conductor (7) as a response to a control signal.
6. A summing network as claimed in claim 3,

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c h a r a c t e r i z e d in that an end of the centre conductor of the coaxial cable is fitted in a cylindrical grounding element (8), and that the adjusting means comprise a transmission mechanism (10) which advantageously  
5 comprises an electric motor for moving the centre conductor (7) or the cylindrical grounding element (8) so that the length of the portion of the centre conductor (7) that is fitted into the cylindrical grounding element (8) changes.

7. A summing network as claimed in claim 3,  
10 c h a r a c t e r i z e d in that the centre conductor (7) of the coaxial cable is grounded by a capacitive diode (11), across which diode (11) a reverse direct voltage is arranged whose magnitude is responsive to said control signal for adjusting the electrical length of the summing  
15 network.

8. A summing network as claimed in any one of the previous claims, c h a r a c t e r i z e d in that said summing network is the summing network of transmission units in a base station of a cellular radio system.

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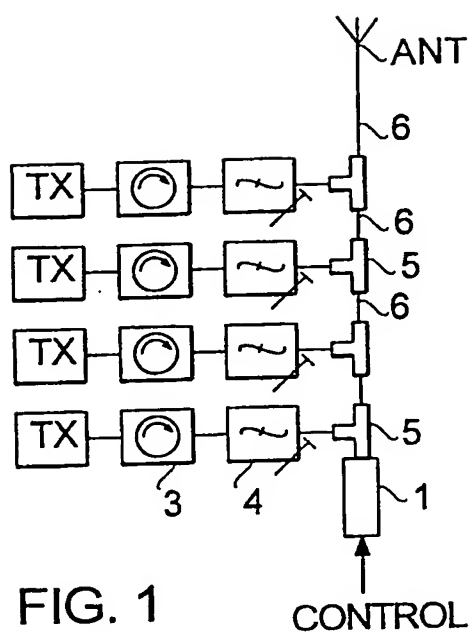


FIG. 1

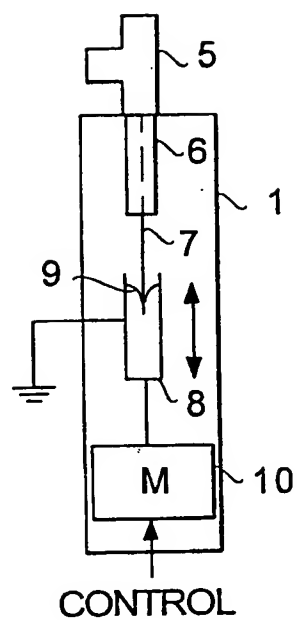


FIG. 2

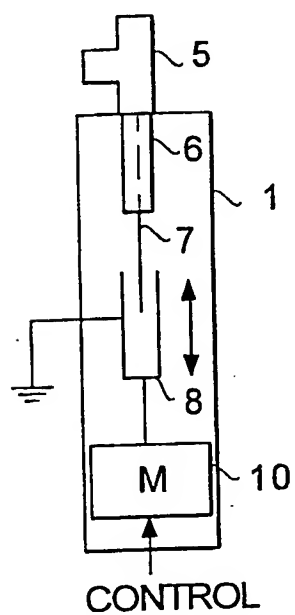


FIG. 3

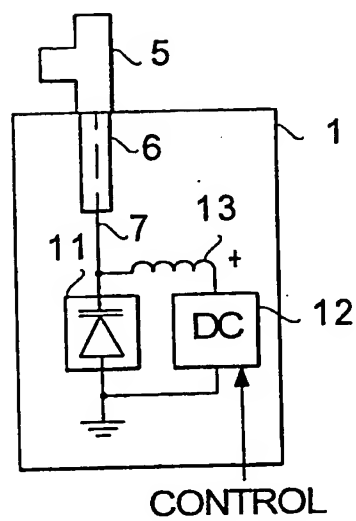


FIG. 4

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/FI 95/00372

## A. CLASSIFICATION OF SUBJECT MATTER

IPC6: H01P 1/213, H03H 7/46

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: H01P, H03H

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

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## DIALOG

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4667172 A (T.F. LONGSHORE ET AL.), 19 May 1987 (19.05.87), figures 2,3,7, abstract --	1
A	US 5235294 A (Y. ISHIKAWA ET AL.), 10 August 1993 (10.08.93), figures 1,3, abstract --	1
A	US 5276409 A (A. PARIKH ET AL.), 4 January 1994 (04.01.94), figures 1,2,4, abstract --	1
A	EP 0494058 A1 (TELEFONAKTIEBOLAGET LM ERICSSON), 8 July 1992 (08.07.92), figures 1,2, abstract --	1

☒ Further documents are listed in the continuation of Box C.☒ See patent family annex.

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## C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0262391 A2 (ANT NACHRICHTENTECHNIK GMBH), 6 April 1988 (06.04.88), figure 1, claim 1, abstract  --	1
A	EP 0101531 A2 (ANT NACHRICHTENTECHNIK GMBH), 29 February 1984 (29.02.84), figure 1, abstract  -- -----	1

**INTERNATIONAL SEARCH REPORT**  
Information on patent family members

02/10/95

International application No.  
PCT/FI 95/00372

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